Vascular Plant Inventory Project Statement

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Introduction

Overview

The five units of the Southwest Alaska Network (SWAN) cover approximately 9.4 million acres of remote land, much of which has received scant botanical attention. The parks range in size from 30,000 acres for Alagnak Wild River (ALAG) to over 4 million acres for both Katmai National Park and Preserve (KATM) and Lake Clark National Park and Preserve (LACL). The complexity of the flora and vegetation is roughly proportional to the size of these parks and to their geographic location relative to major ecoregions or biomes. The highest floristic diversity is found in LACL and KATM, which are not only the largest parks but also the ones with the most diverse elements of coastal and interior Alaska along with azonal habitats ranging from dunes and avalanche chutes to freshwater and halophytic wetlands. A review of existing botanical work revealed large geographic gaps in collecting and inadequate information on the distribution and abundance of plant species of special concern in the SWAN. This project focuses on providing a comprehensive baseline of floristic information from sites throughout these park units.

Previous Work

Plant collections from the Herbarium of the University of Alaska Museum (ALA) and from the herbaria of the various park units (ANCS+) have been entered into NPSpecies as have selected collections from other herbaria and observations and floristic lists from published and unpublished literature. Collections from ALA are verified for both taxonomic identification and geographic location. Collections from ANCS+ are largely unverified for both taxon and geographic location. Prior to the April 2000 scoping meetings, the AKNHP developed lists of taxa known from or expected to occur in each of the parks. The NPSpecies Status categories were used and plant taxa were considered Present in a park only if a verified collection had been made in that park. Taxa that were only known from unverified collections or from observations or literature citations were recorded as Unconfirmed. Taxa known from within 50 km of the park boundary or that were otherwise felt likely to occur in the park were recorded as Probably Present. Using these definitions, we determined what percentage of the total expected flora was known to be present in each park: ALAG 1%, ANIA 82%, KATM 67%, KEFJ 58%, LACL 66%. A recent revision of NPSpecies (as of October 1) indicates that the percent documented of total expected species for LACL is 79%.

Alagnak Wild River (ALAG). Virtually no floristic information exists for this narrow river corridor. We have no records of any collections and only a few unverified observations by park rangers. This park unit is adjacent to KATM and although it is unlikely to contain plant taxa not found in that park, there are very few collections in KATM that are within 25 miles of ALAG. The ALAG survey will likely be conducted by coordinating field activities with the freshwater fish inventory team.

***Aniakchak National Park and Preserve (ANIA*).** Approximately 300 vascular plant taxa have been reported for ANIA, with collections archived at both the park herbarium (as listed in ANCS+) and ALA. The vast majority of these are from the caldera of the volcano and are the result of studies done by Bosworth (1987), Sowl (1988), and Hasselbach (1995). Limited collections exist from Meshik Lake and several coastal locations near Aniakchak and Amber Bays, but little is known from the rest of the park.

Katmai National Park and Preserve (KATM). Close to 400 vascular plant taxa are reliably documented by collections from KATM. Additional taxa are known from unverified collections and observations in literature and field notes. The earliest botanical collections were made from 1915-1930 (Griggs 1936), following the 1912 eruption. Cahalane (1959) made collections in 1953-54 as part of a biological survey, though clearly the main focus was not botanical. Collections were made in the 1970's by Dennis in preparation for an unfinished vegetation map and by Young and Racine (1976) looking at a proposed park extension. Other significant park collections have been made by NPS personnel (e.g., Rice, Moore) and during studies on bear habitat by Smith. Most recently, collections were made by Boggs et al. (in prep.) as part of a landcover-mapping project for the park. The vast majority of collections are from the corridor between Brooks Camp and the Valley of Ten Thousand Smokes and a few coastal locations (e.g., Hallo Bay). Large areas of the park have had no botanical collecting.

Kenai Fjords National Park and Preserve (KEFJ). Over 250 vascular plant taxa are reliably documented by collections from KEFJ, notably by Rice in the 1980's. Most collections are from the Exit Glacier area, Seward, and from scattered coastal areas in Resurrection, Aialik, and Nuka Bays. There are few collections from alpine and subalpine areas (excluding Exit Glacier) or from nunataks. (Nunataks are defined as isolated rock outcroppings that project from ice sheets, ice fields, or glaciers and potentially support unique plant assemblages.)

Lake Clark National Park and Preserve (LACL). The first significant plant collections were made by Racine and Young (1978) and their study provided the basis for much of what is known of the flora and vegetation. The most extensive

collecting has been done by Caswell (from 1996 – 2001) and his collections have greatly enhanced our knowledge of the flora, particularly the less common species. Other significant collections were made by Moore and other park personnel. Bennett and Tande (1996) conducted studies of the coastal vegetation and flora and made significant collections in these areas. The first phase of the SWAN botanical inventory began in 2001 with collections in LACL by botanists from the AKNHP and Caswell. Over 20 taxa new to the park were added to the known flora. Although significant areas of the park remain under-collected, the flora of this park is better known than any other unit in the SWAN.

Objectives

The SWAN team determined that the main goal of the vascular plant inventory would be to document at least 90% of the expected flora of each park. A secondary goal would be to obtain information on the distribution of species of special concern in each park.

Methods

Sampling Design

In order to attain the goal of documenting 90% of the expected flora, we will adopt a reconnaissance method of floristic survey. This method was recommended as the best approach for plant inventories in all Alaska parks by the botanists at the April 2000 scoping meeting and by the Alaska Plant Inventory Working Group at their September 2000 meeting. The reconnaissance method involves identifying survey areas within landscape units via spatial analysis using key criteria such as:

- regionally unique geological or geomorphologic features,
- communities or habitats of biological concern,
- likely habitats of expected species, as indicated by regional floras and park collections,
- under-represented plant communities in existing inventories,
- minimum sample unit allocation to each major ecoregion province delineated in Step 3 of the National Biological Inventory Guidelines, or to other target landscape strata,
- logistical feasibility (e.g., access means, cost), and
- potential of certain types of sites to maximize species and communities encountered (e.g., ecotones, high gradient areas).

This method maximizes the diversity of both species and plant community-types encountered within each survey area.

Ecological sections and subsections will be used as stratification layers for the plant inventories. These stratification units will enable us to maximize species

diversity by sampling ecologically different areas and will distribute sampling throughout each park. Targeted sampling has been incorporated into the plant study design to ensure that sampling occurs in unique sites or habitats where species that are expected, but not yet documented, may exist. Targeted sampling is considered a critical means of reaching the 90% documented occurrence goal as set forth by the Service wide Inventory and Monitoring program. Logistical feasibility (e.g., access means, cost) and the potential of certain types of sites to maximize species and plant associations encountered (e.g., ecotones, high gradient areas) will be incorporated into the study design.

To identify sites to sample we will:

1. Stratify each Park based on ecoregion subsection maps,
2. Identify important geographic gaps in plant inventories within each park by examining the number of collection localities and floristic inventory sites within each stratum,
3. Identify the major ecological gaps in plant inventory data by analyzing the ecological and habitat traits of the pool of expected species for each park,
4. Identify important areas of management concern within under-studied areas, and
5. Prioritize the strata by identifying those subsections that represent both major geographic and habitat gaps in our plant inventory data.

The final site selection process for this study requires detailed examination of aerial photographs, geology, and landcover maps. Where possible, aerial surveys may be used to aid this process. The final selection of sites will aim to:

1. maximize the likelihood of encountering high numbers of park expected taxa and/or species of special management concern per unit access cost;
2. maximize the overall diversity of plant communities, landcover types, and lithologies inventoried within the study area per unit access cost;
3. ensure that all major landscape units (such as floodplains, hill slopes, and wetlands) are surveyed within each area.

Determining the expected species in areas that are poorly known is fraught with difficulty. The method used here—species occurring within 50km of a park—is a very rough approximation at best. Even after revisions are made (based on likely habitats and geography) these lists will undoubtedly need further modification. As the inventory progresses, we expect to be able to refine the numbers. Once a park is at or above the 90% level of expected taxa, we can shift the survey emphasis toward selecting sites that will add information on the distribution of species of special concern. These will certainly include rare or sensitive taxa, but

may also include invasive species or species felt to be susceptible to disturbance.

This targeted, judgement-based approach will identify species of special concern and attempt to locate additional populations based on known habitat preferences and patterns of distribution. As surveys progress the lists of species of special concern will be refined as will our knowledge of their habitat and geography increases.

Field Methods

Fieldwork will be done by 1 – 2 teams of two botanists each. Access to sites will be by fixed-wing aircraft or boat, where possible. At each site we will make a complete floristic inventory including using the following methods.

- Each site will be mapped on an aerial photo or USGS topographic map and a georeference point will be recorded using GPS. The routes surveyed will be mapped. Representative photos will be taken of each site including communities, unusual landforms, and notable plants.
- A description of each site will be recorded and significant landforms and plant associations described.
- As new communities are encountered, the following data will be recorded: Viereck vegetation type to level 4 or 5 (Viereck et. al. 1992), slope, aspect, elevation, topographic position, moisture, soil types, parent material, cover classes of growth forms and bare ground, and dominant species by growth forms.
- A complete species list will be made for each site, listing the community types each species occurs in, where possible.
- An aerial-oblique photo of the site and significant plant associations will be taken on departure.
- Vouchers will be collected and curated as discussed below.

Vouchers and Curation

Vouchers specimens will be collected for those species that are new to the park or ecoregion, species of concern (rare, endemic, invasive), geographic or ecological range extensions and specimens not identifiable in the field. For selected species, leaf tissue will be collected and held in silica gel for genetic analysis; a complete voucher specimen will accompany all tissue collections. The following data will be collected for each vouchered specimen: date, unique collection number, latitude and longitude (NAD27, decimal degrees); slope, aspect, elevation, topographic position, associated landforms, associated species, Viereck vegetation class, substrate, soil moisture, soil type, drainage, parent material, cover class and frequency class, notes on characters not preserved well, associated photo number, phenology and ecological

observations. The size of the population and area surveyed will be included for species of concern.

Collections will be made only if the population is large enough to support removal of individuals and will follow the collecting protocol of Parker and Murray (1992). Duplicate collections will be made when possible, allowing the first set to be archived at the Herbarium of the University of Alaska Museum (ALA) and the second set to be sent to interested parks with storage facilities.

Specimens will be sorted, examined and determined by the botanists who collected them and the collections sent to ALA where notable finds and difficult taxa will be reviewed by the Museum staff. As needed, specimens will be sent out to authorities by ALA for determination.

A cooperative agreement has been initiated with ALA for curation. Specimens to be archived at ALA and those to go to park herbaria will be prepared at ALA.

At the park level, specimens will be curated through the import of data into ANCS+. Specimens returned to parks from ALA will need to be filed and accessioned. In addition, catalog ledgers will be updated and loan forms completed. Rare plant sighting forms (with maps) will be completed for taxa with an AKNHP rank of S3 or less.

Products

1. A complete set of mounted and curated voucher specimens, to be housed at the Herbarium of the University of Alaska (ALA), with a potential set of duplicates supplied to some parks, depending on park needs.
2. Fully populated NPSpecies, and ANCS+ databases for each park unit.
3. Annual reports describing the results of the inventory in each park unit.
4. Final report documenting the inventory, including identification of additional survey and research needs and management recommendations for inventory and monitoring.
5. An annotated species list describing all taxa and the basic geographic and habitat attributes of each for each park unit.
6. Preparation of park level rare plant species lists for each unit, with notes on conservation status, biogeographic affinities, habitat preferences and related data.
7. Publication-quality distribution maps for selected species such as species of special concern or major range extensions that result from this project.
8. GIS data layers with links to plant databases.

Project Timeline

October 2001 – February 2002
LACL specimen identification, specimen preparation, mounting, and curation, data entry, slide labeling, complete AKNHP rare plant sighting forms, complete project documentation. Prepare site descriptions and annual report covering results of 2001 fieldwork.

January 2001 – June 2002:
Final site selection for KATM and ALAG plant inventory fieldwork, hire project personnel, procure equipment and supplies for project and perform logistical planning for summer 2002 fieldwork.

June – August 2002:
KATM and ALAG plant inventory fieldwork.

September 2002 – February 2003:
KATM and ALAG specimen identification, specimen preparation, mounting, and curation, data entry, slide labeling, survey route digitization, complete AKNHP rare plant sighting forms, complete project documentation. Prepare site descriptions and annual report covering results of 2002 fieldwork.

January 2003 – May 2003:
Final site selection for KEFJ and logistical planning for summer 2003 fieldwork.

June – August 2003:
KEFJ plant inventory fieldwork

September 2003 – January 2004:
KEFJ specimen identification, specimen preparation, mounting, and curation, data entry, slide labeling, survey route digitization, complete AKNHP rare plant sighting forms, complete project documentation. Prepare site descriptions and annual report covering results of 2003 fieldwork.

February 2004 – May 2004:
Final site selection for ANIA and additional LACL sites and logistical planning for summer 2004 fieldwork.

June – August 2004:
ANIA and LACL plant inventory fieldwork

September 2004 – February 2005:

ANIA and LACL specimen identification, specimen preparation, mounting, and curation, data entry, slide labeling, survey route digitization, complete AKNHP rare plant sighting forms, complete project documentation. Prepare site descriptions and annual report covering results of 2004 fieldwork.

NPSpecies data entry, project curation, ANCS+ data import and NPS specimen curation, floristic analyses, prepare final report for SWAN inventory.

Contributions, Coordination, and Logistical Support

NPS data managers will complete entries into the ANCS+ database based on spreadsheets supplied by the AKNHP. The SWAN Biological Inventory Coordinator will complete final report preparation based on individual park summaries and data provided by the AKNHP.

Wherever possible, we will attempt to coordinate botanical inventories with other inventories or projects in the parks. Other NPS contributions will include housing, transportation by boat within parks, and safety and field equipment to the extent possible for inventory work. When possible, Parks/Preserves will provide within-park transportation by aircraft in coordination with other projects.

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Freshwater Fish Inventory Project Statement

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Introduction

Problem Statement

Freshwater fishes are an important component of ecosystems within Alaska Parks. Many issues surround freshwater fishes, particularly as the National Park Service becomes more deeply involved in subsistence fisheries management. Unfortunately, little is known about the occurrence, distribution or relative abundance of many freshwater fish species within the Southwest Alaska Network. To date, only Katmai National Park and Preserve (KATM) and Lake Clark Park and Preserve (LACL) have received fairly comprehensive freshwater fish surveys that document the occurrence of freshwater fishes of consumptive and non-consumptive value. Since much of our current freshwater fish knowledge focuses on species harvested by subsistence or sport users, other park units (i.e., Aniakchak National Monument and Preserve (ANIA), Alagnak wild River (ALAG), and Kenai Fjords National Park (KEFJ)) lack basic occurrence information about the remaining species. This suite of species includes blackfish, grayling, lamprey, pike, sculpin, sticklebacks, whitefish and others. All parks lack comprehensive data on distribution and relative abundance of most non-commercial freshwater fishes. Without baseline data on species occurrence, park resource managers are unable to make well-informed fisheries management decisions or accurately assess the potential impacts of mining, logging, development projects and/or consumptive uses to aquatic ecosystems.

Objectives

To document through targeted sampling the occurrence of 90% of freshwater fish species expected to occur in lakes and streams in the Southwest Alaska Network.

Inventory Priorities

Network inventory priorities are to conduct targeted field investigations by collecting occurrence data that will result in achieving at least 90% documentation of expected freshwater fish species. Targeted inventories will be conducted in ALAG, ANIA, and KEFJ based "need" according to compiled and verified data available on NPSpecies (referenced in Study Plan). The percentage of documented, expected freshwater fish for each park is: ALAG-22%, ANIA-20%, KATM-100%, KEFJ-60%, and LACL-100%.

Once the 90% documentation goal has been met, inventory efforts will concentrate on gathering distribution and relative abundance data for species of special concern for monitoring (i.e., blackfish, charr, chinook, grayling, slimy sculpin) in LACL or KATM.

Table 1. List of expected yet undocumented freshwater species for ALAG, ANIA, and KEFJ.

ALAG: Catostomus catostomus , Coregonus clupeaformis, Coregonus sardinella, Cottus aleuticus, Cottus cognatus , Dallia pectoralis, Esox lucius, Gasterosteus aculeatus, Hypomesus olidus, Lampetra japonica, Lota lota, Prosopium coulteri, Prosopium cylindraceum, and Pungitius pungitius
ANIA: Catostomus catostomus, Cottus aleuticus, Dallia pectoralis, Lampetra japonica, Lampetra tridentata, Prosopium cylindraceum, Pungitius pungitius, and Thymallus arcticus.
KEFJ: Catostomus catostomus, Cottus aleuticus, Eleginus gracilis, Lampetra tridentata, and Prosopium cylindraceum,

Sampling Design

Sampling Considerations. Targeted sampling will be conducted in at least three of the five SWAN units in order of greatest need. Based on current species lists generated from the NPSpecies database, ALAG, ANIA and KEFJ have the least amount of information available about species occurrence and are therefore primary inventory priorities for freshwater fish. Judgement-based, non-random sampling efforts will be conducted in habitats likely to support expected but undocumented species, areas that represent gaps in our knowledge base, management information needs, and access. Targeted sampling in this manner will increase the likelihood of documenting 90% of the freshwater fish species expected to occur within park boundaries. The principal investigator, resource managers, and inventory coordinator will identify potential watersheds to be sampled within each park.

Sampling Scale. Sampling will occur at the watershed scale. Fifth order watersheds will be identified using GIS analysis. Where watersheds reach the

ocean before becoming fifth order or where a fifth order grouping does not seem to be appropriate, professional judgment will be applied.

Within watersheds, streams will be classified by stream order and lakes by 'connectedness' (see below) and elevation. First order streams will not be sampled as part of this effort. Second through fifth order streams will be sampled. Streams that are greater than 15 percent in gradient will be assumed to be rarely fish-bearing and will not be targeted for sampling. Stream order strata will be developed through GIS, resulting in a map displaying stream order strata within fifth order watersheds.

Streams greater than fifth order will be separated into 3 approximately equal sections starting at the downstream end of NPS jurisdiction and continuing upstream to the upstream end of NPS jurisdiction. These stream sections will be divided into reaches delineated by the confluences of fifth order or larger tributaries. Watersheds that are less than fifth order, draining directly into streams larger than fifth order, will be combined with these river reaches and serve as potential low order stream sampling sites. Sampling in these river reaches will be similar to the description for sampling in streams but will likely require a boat.

Lakes will be classified based on stream 'connectedness' to streams less than 15 percent in gradient. Lakes will be classified as "open" (if they are connected to a stream permanently or seasonally) and "closed" (if not connected to a stream or connected only during rare high water or flooding events) and by elevation.

Methods

Sample site selection and sample size.

Targeted sampling. Due to budgetary constraints, sampling will be conducted in a few "core areas" and limited to collecting and documenting presence information only. (Future sampling efforts to capture presence and absence data may be incorporated during the monitoring phase.) Between three to five watersheds will be selected for intensive and systematic sampling in areas that represent important and/or typical habitats in the park. Within these areas, the principal investigator, resource manager, and inventory coordinator will identify lake and stream areas/habitats with a high likelihood of capturing expected but undocumented species. These areas will be divided into 10 to 20 sampling units. Streams will be divided into units that can be reasonably sampled within approximately 12 hours with gear appropriate for the targeted species. Each lake will be considered an individual sampling unit. Up to 20 samples per site will be collected to minimize the possibility of collecting an "absent" sample. The principal investigator will have final discretion to decide if more samples are needed to document the remaining predicted species.

Targeted sampling will allow for efficient use of limited resources by emphasizing those areas where expected species are anticipated to occur. However, this approach may limit the opportunity to extrapolate results from habitat-to-habitat within parks or among parks. Extrapolation of results downstream of sample sites will be more likely where ample data are collected especially for common or abundant species. Upstream extrapolation will be very limited. Preliminary expectations of distribution based on extrapolated data will not be released as a product for NPS management, but may be used to plan future I&M efforts.

Field Methods

To document the presence of expected and/or unconfirmed species, we will sample representative habitat-types during key life-history phases of non-anadromous species. Data will be collected using standardized field forms that meet regional criteria and are consistent with other networks (examples attached). Species identification, specimen size, sex, and condition information will be collected for all species captured. We will retain a portion or entire voucher specimen depending on species identification. Species that are difficult to identify may be retained as whole specimens, otherwise a small section of tissue for genetic analysis will be collected. Where possible, sex will be determined by external examination. For all species, lengths will be taken to the nearest millimeter; salmon will be measured from mid-eye to fork of tail and other species will be measured for total length. Weights will be taken to the nearest .01 kilogram. This information will be collected while minimizing mortality levels.

Habitat descriptions and measurements will be collected to characterize the sample site. In streams the data obtained will include channel gradient, channel width, average depth and water velocity information. Habitat units will be described as pools, glides, riffles, rapids, or side channels. In lakes, area, length and width will be estimated. Ten water depth measurements will be taken randomly throughout each lake. Water temperature and water clarity data will be collected in both lakes and streams. Additional water quality data may be collected in conjunction with the water resources inventory team.

Fish capture methods will vary between lakes and streams. Lake sampling will be conducted using gillnets, minnow traps, hoop traps, fyke traps, hook and line sampling and visual observations for some species. Variable mesh gillnets will be fished throughout the water column. At selected lakes, crew members will camp overnight to perform an additional evening set of nets and traps as well as hook and line sampling. Visual observations of easily identified fish species, such as adult salmon, Arctic grayling, and northern pike will be included in the data set. Lake sampling will require an inflatable raft with a motor and transportation to most sample sites will be by floatplane or boat.

Stream sampling will include use of minnow traps, beach seines, drift gillnets, hook and line sampling, dipnets, visual observations, and backpack electrofishers as appropriate. Six to 30 minnow traps will be deployed per site in a range of habitat types (pools, riffles, eddies, side channels) where possible. A combination of trap baits will be used, including salmon eggs, dry cat food, canned tuna or salmon. Beach seines and dipnets will be used where conditions permit. Where existing information, or preliminary sampling with methods other than electrofishing, indicates that rainbow trout or steelhead do not exist, backpack electrofishers will be used in small streams. Should this method be employed, crew members will install block nets at the upstream and downstream ends of an approximately 100 meter stream segment that encompasses at least 2 habitat types (pools, riffles, side channels) prior to electrofishing and will then make a minimum of 2 passes electrofishing removing captured fish. A pass will be considered the combination of electrofishing once upstream and downstream through the stream segment. Some discretion as to the combination of specific methods utilized at each site will be left to the field crew leader. For example, where beach seines can be successfully fished, electrofishing will not be necessary or if electrofishing is necessary then it will likely be the only method utilized. Floatplane transport will be required to reach sample sites and put-in points for sampling requiring raft access.

It is understood that the geographic distribution of fish varies from season to season. Not all species endemic to a drainage will be present in a particular location at any given time. For this reason, habitats selected for sampling will be selected to optimize the probability that capture of all species is likely to occur within that watershed.

Crewmembers will record sampling effort and conditions affecting the success of sampling efforts at each site. Throughout the season we will estimate capture efficiency for each gear type in different habitats. If capture efficiency appears lower than the assumed 25%, the principal investigator will meet with resource managers to determine if the number of sample sites should be increased.

Vouchers

Sampling mortality will be kept to a minimum. Some mortality is expected and specimens killed while sampling will be used to produce a voucher collection. Collection of voucher specimens will be limited to species not easily identified in the field such as juvenile salmon and whitefish; fish accidentally killed during capture; and species not previously documented in the network. Single specimens of all rare or unknown taxa and fin clips from at least 40 individuals (where possible) from the common or easily identified taxa per site will be archived for genetic processing. Fin clips will be stored in ethyl alcohol. Long

term storage of the specimens will be arranged with University of Alaska Museum. Incidental catch or observations of amphibians also will be documented using the "Amphibian Flashcards" and field forms produced for the opportunistic inventory of amphibians described in the SWAN Study Plan.

Data Management
All crewmembers will be trained in fish capture techniques, identification, specimen preparation, habitat measurements, and data recording techniques. Assistance from University of Alaska Museum curator of fishes will be requested to ensure collection techniques reflects museum standards and data needs. Final determination of difficult species will be conducted at UAM by taxonomic experts.

The principal investigator will be responsible for a literature search on freshwater fish species (for each park) is compiled, data collection, data entry, updating the national databases (NPSpecies, ANCS+, NRBib, and the Dataset Catalog) and working with appropriate individuals to produce GIS products displaying the results. The principal investigator will also ensure that data are imported correctly from Excel into an Access database. All data will be transferred from hardcopy after initial data entry. The Access database will be linked to GIS coverage produced in ArcInfo. Each park will receive copies of the databases containing information collected within their boundaries and data may also be posted on the regional inventory website. The principal investigator will be responsible for writing the final report summarizing inventory efforts and results.
Two copies of datasheets will be made, one copy will be stored with the inventory coordinator and the second copy will be stored at KATM with the principal investigator until the final report is completed. Detailed field notes will be kept by all field staff and retained as part of the permanent archival information for the project.

Data Analysis
Species will be determined to be present within a watershed if they are found or previously documented as present at sample sites within the watershed. We will not sample intensively enough to document absence. Occurrence data will be developed and displayed using various themes.

Project Timeline

October 2001 through April 2002
Assemble workforce (Hire principal investigator)
Complete literature search for all existing freshwater fish inventory data for each park unit

Enter existing freshwater fish inventory data into GIS database
Resource managers, principal investigators, and inventory coordinator meet to select waterbodies and sample sites
Develop database structures and link to GIS layers
Refine individual park inventory study plans
Refine field forms
Coordinate logistics including OAS and housing
Purchase equipment

May 2002 through September 2002
Initiate freshwater fish inventories in ALAG
Once ALAG is complete, initiate inventory in KEFJ

October 2002 through April 2003
Review first field season and refine study plans if needed
Compile, enter and analyze data and produce GIS layers
Prepare annual progress report

May 2003 through September 2003
Begin and complete inventory in ANIA
Depending on progress, KEFJ inventory begins

October 2003 through April 2004
Compile, enter and analyze data and produce GIS layers
Prepare annual progress report

May 2004 through September 2004
Begin and/or complete inventory in KEFJ
Supplemental sampling of KATM or LACL for distribution and relative abundance

October 2004 through December 2004
Complete compilation and analysis of data.
Finalize GIS layers in Arcview showing results.
Produce copies of Access data on CD media.
Enter data into NPSpecies and ANCS+.
Produce final report summarizing results.

Park Contributions, Coordination and Logistical Support
KATM will contribute a GS-9 or GS-11 Fishery Biologist to serve as the principal investigator through the duration of the project for all park units throughout the network. Project activities and logistics will be coordinated by the principal investigator, inventory coordinator, and an inventory contact person for each park. Park contributions include boats, motors, housing, and safety equipment

necessary for inventory work. When possible, Parks/Preserves will provide within-park transportation by aircraft in coordination with other projects.

The inventory coordinator and principal investigator will identify opportunities to leverage funds and coordinate research efforts within NPS such as those programs presently funded through the Office of Subsistence Management. For example, we will explore opportunities to hire recent "graduates" from the Training Center Pilot Program which is being supported by NPS and the Department of Labor to train local residents in fisheries techniques at the GS-5 level. We will also work to coordinate and collaborate with other agencies or organizations including the USGS-BRD, University of Alaska, and Alaska Department of Fish and Game, etc.

Products

The project will produce written reports (annual progress and final reports) describing the methods used, effort, results and a discussion of the results for each park unit. Written reports will be reviewed by the Inventory Coordinator, forwarded to the Regional I&M Coordinator and incorporated into the regional inventory website. The project will produce a network-wide Access database of inventory results on CD media that can be updated as additional surveys are performed. The project will produce Arcview GIS layers by watershed showing the presence of each documented species; hard copy maps will also be produced. Species information will be used to update national databases (NPSpecies, NRBib, and the Dataset Catalog).

Voucher specimens will be identified, labeled, cataloged in ANCS+ (the NPS collections database), and housed with the University of Alaska Museum collections.

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Small Mammal Inventory Project Statement
of Alaska's National Parks and Preserves -- Southwest Alaska Network Study Plan

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Introduction

The current number of documented mammalian fauna in Alaska includes 108 species (excluding human beings), representing 71 genera, 28 families, and 8 orders in recent times (since the last glaciation or Holocene) (MacDonald and Cook 2001). These include about 45 species of small mammals (shrews, bats, weasels, rodents, pikas, hares). Typically, abundant and detailed information exists on the occurrence, distribution, abundance, life histories, etc. of large terrestrial mammal species such as ungulates and large predators. However, less is known about the smaller terrestrial species.

At the April 2000 Biological Inventories Scoping Meeting, participants found that knowledge regarding the occurrence of small mammal species was either incomplete or absent for many park units. Acquiring basic information about their occurrence, distribution and abundance emerged as a high priority for the Southwest Alaska Network (SWAN). Review of the NPSpecies Database for mammals species indicates that 45 to 83% of expected small mammal species have been documented in SWAN park units (Table 1). A list of expected species is available in Appendix A.

Table 1. *Summary of documented species, expected species, and percent documented species for large* terrestrial and marine mammals and small terrestrial mammals in SWAN park units generated from the NPSpecies Database.*

Park Unit	***Documented Large Mammals***	***Expected Large Mammals***	***% Documented Large Mammals***	***Documented Small Mammals***	***Expected Small Mammals***	***% Documented Small Mammals***
ALAG	12	13	92	10	22	45
ANIA	14	14	100	15	18	83
KATM	19	19	100	21	27	78
KEFJ	26	30	86	18	22	82
LACL	20	20	100	16	25	64

According to the NPSpecies database, “documented species” are defined as species documented through literature, historic collections, and/or verified reputable observations. “Expected species” are defined as documented species plus those species “expected” to occur within park boundaries yet remain undocumented.

Justification

Natural resources in parklands face increasing and complex pressures from development, visitation and recreation, subsistence hunting, resource extraction, habitat degradation, and climate change. In light of these pressures and the desire to effectively manage biological resources within parks, biological inventories are being conducted to document at least 90% of the expected species for several taxa including small mammals. Small mammals play a pivotal role in the food chain in subarctic Alaska, providing a large proportion of the prey available to small and medium-sized predators. Additionally, because abiotic factors (i.e. precipitation, temperature) influence boreal microtine populations these species may be useful indicators of ecosystem change. By facilitating morphological, genetic and parasitic investigations of this important segment of the mammalian fauna, this inventory will result in a multidisciplinary (and cost-effective) view of biotic diversity of NPS lands.

Given the various ways of viewing the hierarchical organization of biodiversity—ecosystem, species, and genetic, or as compositional, structural and functional systems—conservation and management strategies may be necessary at many levels (Heywood 1994). Assessments of genetic diversity can provide an understanding of taxonomy, phylogeographic variation, and systematic relationships. These kinds of studies are emerging as a central means of improving resource management. According to Forey et al. (1994), genetic assessments contribute directly to resource management by improving the ability of managers to establish conservation priorities. Molecular genetic approaches provide a spatial and temporal framework for investigations and management of biotic diversity.

DNA sequence variation of small mammals within Alaska parks can be assessed by analyzing genetic material collected from relatively small sub-samples of individual populations. Small mammal specimens archived from this inventory project will provide insight into the spatial extent of population level differentiation; will help reconstruct historical biogeography; and will define conservation and management priorities (MacDonald and Cook 2001). For example, by investigating the genetic structure of small mammals and their contemporary geographic distribution, we can uncover systematic and taxonomic differences and geographic patterns of genetic variation within natural populations. In addition, genetic records provide documentation of historic biotic diversity for the assessment of change due to natural or human-induced perturbations. (For additional background on small mammal phylogenetics and its potential use in conservation evaluation, please see Appendix B.) Investigations of parasites and pathogens of these specimens, as well as morphologic variation, will provide additional insight into significant management units and the health of these natural populations.

For this project, we propose sampling small mammal occurrence, relative abundance, distribution, and parasitic fauna using a combination of targeted judgement-based, and random sampling in under-sampled and logistically feasible locations.

Objectives

The goals of this project are twofold. The first goal is to improve baseline knowledge of small mammal occurrence in the SWAN parks. A supporting goal is to improve our current knowledge of small mammal systematics and distribution that inhabit Alaska. We will address these goals through the following objectives:

1. Document through targeted field investigations the occurrence of 90% of the expected small mammal species as well as the relative abundance, distribution, and habitat associations of the most common species.

2. Examine small mammal taxonomy and zoogeography of selected species within SWAN units, and provide material for future investigations in parasitology and genetics.

Methods

Sampling Site Selection

Sampling strategy and design for the SWAN parks is consistent with methods used to collect similar data in Northwest Alaska Network (NWAN) and Central Alaska Network (CAN) units, which will facilitate regional application of results. The sampling strategy will employ a combination of judgement-based and random sampling. Maps stratified at the ecological subsection level will be used to identify broad biogeographic units from which to sample. The site selection criteria listed below for judgement-based sampling will be used to identify 80% of the candidate sites.

Sites may:

- represent under-sampled areas (knowledge "gaps"),
- possess a high probability of capturing expected species,
- are located within representative ecological subsections,
- reflect important resource management issues,
- are accessible for current operations and long-term monitoring, and/or;
- possess other noteworthy characteristics (i.e., important ecological processes or unique community).

Once the majority of potential sites have been identified using the above criteria, the remaining sites (20%) will be randomly selected from stratified ecological subsections. Randomly selected sites will minimize bias associated with the site selection process and may prove useful for future monitoring efforts. By evaluating the list of candidate sites, 3 to 5 "core" sampling sites will be identified from which to establish a base of operations and to conduct inventories. Between 10 and 15, 100-500m transects will be sampled per site. The area of the site is defined be the maximum walking distance of crewmembers thereby limiting the scope of the sampling area.

Using topographic maps and park staff knowledge of selected sites, we will evaluate the feasibility of operating at the randomly selected sites. In instances where the site is unsuitable, the closest site within a 1-km radius will be selected. If no suitable sites can be located within that radius the next alternative site will be selected.

Capture and Collections

Standard and non-standard belt-transects (traplines) will be used to document the occurrence of expected small mammal species. Transects will be established by randomly locating one end-point but may be oriented along a transitional zone or gradient. We will concentrate sampling effort in edge and patchy habitats (e.g. the margins of ponds and streams, talus slopes, and blow-down areas) and elevational gradients to maximize diversity of species collected.

Small mammal trapping will be conducted from mid-July to August when populations are at their peak and the ability to detect and capture less common species is greatest. Field surveys will consist of both targeted and opportunistic sampling that employs different trapping techniques. *While conducting field inventories, a primary focus of all efforts will be to document the occurrence of expected species.*

Removal sampling methods will be used to document species occurrence, relative abundance, and investigate genetic differentiation. To minimize trap bias, a variety of capture devices may be used including museum special snap traps, pitfall traps, rat traps, conibear, snares, and leg-hold traps. All specimens collected will be preserved and archived for future research and museum use.

Specimen-based inventories, which are recognized as essential to good science, require large sample sizes through removal sampling for the following reasons:

- Various shrews and small rodents are difficult or impossible to identify without specimens in-hand. Close examination of tooth pattern, body measurements, and other characteristics is necessary to differentiate Alaska's shrews. *Microtus* voles can also be especially difficult to differentiate. *M. oeconomus* and *M. pennsylvanicus*, in particular, are so similar that positive identification requires examination of molars under magnification.
- Many captures of the most common and widespread species may be necessary in order to document rare and uncommon ones.

As noted by Reynolds et al. (1996), the number of animals removed from a population has no biological significance unless it is related to the total number of animals in the population and their rate of replacement. Alaska's small mammals are short-lived and prolific, with reproductive potentials more than sufficient to accommodate low levels of removal found in this inventory project.

Target Species

Shrews, Voles, Mice, Lemmings. Shrews, voles, mice, and lemmings are surveyed using standardized methods developed by UAM. Standard belt transects (trapline) are established using of 20 to 40 trap stations. Transect length is typically 100m and trapping stations are placed approximately 8m apart. At each station, either 2 museum special snap traps or 1 snap trap and 1 pitfall trap (primarily for shrews and lemmings) are set within 2m of each station point. Snap traps are baited with a mixture of rolled oats and peanut butter. Pitfall traps are unbaited and buried. Traplines are operated continuously for 2 or more nights depending on trapping success. A maximum sample size of n=30/species/site for most species of shrews, shrews, voles, and lemmings will be collected in all parks. However, a maximum sample size of n=45/species/site for red-backed voles and cinerus shrews may be collected in all parks. *Traplines are checked twice daily for captures*.

Squirrels. Sciurids (flying squirrels, red squirrels, marmots, and arctic ground squirrels) are taken opportunistically using shotguns or by establishing special transects in conjunction with shrew-vole traplines. In forest habitats, standard transects are used with rat traps tied upside-down in trees to capture flying and red squirrels. A limited series of marmots and squirrels (up to n=5 to n=10/species/site) may be collected from any one sampling area in KATM only. A maximum sample size of n=2/species (for the entire park) may be collected using shotgun methods in LACL. To reach a sample size of n= 5 to n=10 in LACL, specimens will be acquired through collateral take. No squirrels or marmots will be collected in KEFJ.

Bats. Bats species are typically rare except along coastal regions of southcentral and eastern Alaska. In general, bats are difficult to collect and identify out of hand (Nagorsen and Brigham 1993). Bats will be captured with mist nets placed in strategic areas or hand-captured at roosts. To identify potential sampling sites (e.g., outbuildings, mines, etc.), we will contact local people. Bats are collected opportunistically. No bats will be collected in KEFJ.

Hares and Pikas. Lagomorphs, like squirrels, are taken opportunistically by trap or shotgun. Wire snares set along trails are effective for capturing snowshoe hares. Hares require shotgun sampling methods. Pikas are collected using light-load shotguns, rat traps, and/or box traps. A limited series of lagomorphs (up to n=10/species/site) may be collected in KATM only. A maximum sample size of n=2/species (for the entire park) may be collected using shotgun methods in LACL. To reach a sample size of n=10/species/site in LACL, specimens will be acquired through collateral take. No hares or pikas will be collected in KEFJ.

***Weasels*.** Specimens of ermine and least weasels are most frequently documented as incidental captures by furbearer trappers during the winter months. Box traps set in suitable habitat occasionally work, as do rat traps. Weasels are occasionally collected with a light load shotgun. A limited series of weasels (up to n=10/species/site) may be collected from any one general sampling area in KATM. A maximum sample size of n=2/species (for the entire park) may be collected using shotgun methods in LACL. To reach a sample size n=10/species/site in LACL, specimens will be acquired through collateral take. No weasels will be collected in KEFJ.

Supplemental Sampling

Opportunistic sampling of various species will be conducted through shrew-vole traplines, rat traps, mist nesting, wire snares, shotgun or rifle sampling, and collateral take by trappers or some combination of these methods. Emphasis will be placed on documenting expected species using these methods. Opportunistic shotgun or rifle sampling of weasels, hares, pikas, and squirrels will not be conducted where safety concerns have been expressed or in areas of potential park visitor interactions (e.g. LACL and KEFJ). Shotgun/rifle sampling will be limited to sample sizes as described in the previous section (Target Species).

When feasible, we will coordinate small mammal trapping efforts with the activities of other inventory studies (e.g., vascular plant inventory). We will also train and accompany NPS staff willing to collect targeted small mammals during the course of their regular field duties.

Collateral take is the acquisition of target specimens through secondary or indirect means, such as purchase from trappers*.* Specimen acquisition through collateral take may be conducted as an alternative to opportunistic shotgun or rifle sampling to document squirrels, marmots, hares, pikas, and mustelids. A high degree of emphasis will be placed on acquiring the above species through collateral means in LACL. This will be achieved by working closely with park managers the winter preceding fieldwork to identify interested trappers.

Carcasses of these species obtained from trappers will be acquired with locality and date information. However, it is unlikely that these specimens will be associated with detailed habitat information.

Non-Destructive Documentation

To ensure I&M goals of 90% species documentation are met, non-destructive documentation will be necessary. In lieu of voucher specimens collection from shotgun sampling and collateral take in some parks as described above, expected species will be documented by recording visual observations and/or

photo documentation. Standard information regarding species habitat, location, etc. will be recorded when expected or target species are sighted and/or photographed.

Minimum Sample Size

What constitutes an adequate or minimal sample size for documenting diversity is not easily determined. Wilson et al. (1996) notes that, for some species, careful documentation is possible using few specimens, although this is rare. For others, 20 specimens may not adequately sample the variation in the population, requiring a larger sample size. An operational guideline put forth by Wilson et al. recommends collecting 10 to 20 specimens per species from well-studied sites for identification purposes, unless a further objective such as measuring genetic diversity is pursued. According to Scoping Meeting participants, SWAN units are not considered well-studied. In general, series of specimens from particular localities are necessary to examine variation within and among species. When compared to levels of natural mortality and accidental kills, museum collection has an insignificant impact on wild populations (Wilson et al. 1996).

For the purposes of investigating systematics and genetic variation, the minimum sample size necessary to reveal statistical differences among many natural populations is between n=10 and n=50 individuals per population per species depending on inherent levels of intraspecific variation (Takazaki and Nei 1996; Avise 2000). Statistically, a sample size of 30 ensures that assumptions of normality are met according to the central limit theorem (Mendenhall, et al. 1999). Empirical evidence from small mammal studies in Alaska (e.g., Bidlack and Cook 2001) indicates that 20-30 individuals is a reasonable trade-off between sampling (and laboratory) effort and costs and the rigorous statistical assessments of natural variation. Larger sample sizes allow for greater statistical power and more accurate divisions between populations. Because many parasites or viruses occur in low frequencies in many natural populations (<5%), very large sample sizes (up to 200 individuals) are needed to thoroughly sample these important biological pathogens. Hence, our sampling methods will reliably sample only common pathogens in these natural populations. Our sampling scheme for shrews and small rodents (up to about n=30 individuals per site) will provide adequate numbers for most analyses. The number of specimens per species actually collected from any given park will depend on whether it occurs in the region, the availability of suitable habitat, and its overall level of abundance during the period of sampling. Small mammal species of unknown or questioned occurrence will receive added attention in an attempt to increase documentation of expected species and satisfy the first objective. All animals collected will be preserved as a scientific specimen.

Data Collection

Trapline Datasheets. Information recorded includes location, date, weather, collector's name, elevation and general habitat notes. Vegetation classification is recorded at each site according to Viereck et al. (1992) to enhance habitat descriptions. Locality* information is collected using a GPS unit to capture latitudes and longitudes at each site.

Field Journals, Specimen Catalogs, Annotated Maps. Regular field journals, specimen catalogs, and annotated maps are kept and will be available at the completion of the project for archiving.

Each specimen and their associated materials, such as frozen tissues, and parasites, are assigned one catalog number. All materials are thus linked through a single catalog number. Catalog sheets are prepared prior to field season to increase efficiency in the field. A sample page of the museum's specimen catalog is available in Appendix C.

Specimen Handling

All animals collected in the field will be treated humanely and in strict accordance to the standards and guidelines established by the American Society of Mammalogists. All animals collected will be processed and preserved. The contractor is responsible for the long-term storage and archiving costs associated with this collection.

Field preparation methods for mammals and parasites follow standards provided in the Smithsonian's *Measuring and Monitoring Biological Diversity: Standard Methods for Mammals* (Wilson et al. 1996). Specimens are removed from traps and placed into separate plastic bags to retain ectoparasites.

Specimens from each trapline remain together until final processing and are labeled with location, date, trapline number, and collector's name. Specimens are kept cool and prepared each day to maximize quality of sample. Species identifications are made in the field. Specimens are examined for ectoparasites, standard biological measurements are recorded, and reproductive condition is noted. Parasite data yield valuable information for constructing historical biogeography as well as site specific conditions (Brooks and Hoberg 2000, 2001).

Specimens are vouchered using standard formats: study skin and skeleton, skeleton, and as whole-body in ethanol. A variety of preservation techniques are used to maximize analysis potential for genetic, taxonomic, systematic, and parasitic study. However, specimen-vouchering methods are dependent on rarity, age, and specimen condition. Ethanol preservation is the most common and

efficient method of preservation. This method vouchers the entire animal retaining stomach contents and reproductive organs, which are discarded when preparing skins and skeletons.

Liquid nitrogen is used in the field to preserve various frozen tissues for a wide variety of genetic, molecular, parasite, disease, and other studies. Nitrogen is transported in non-pressurized tanks. Tanks are secured upright within the aircraft and taps are taped shut. Tissue samples are permanently stored in ultra-cold freezers at UAM and ISU. Ethanol is used for preserving ecto- and endoparasites, feces, stomach contents, etc. All preparation materials that are brought into the field are removed from the field.

The UAM Mammal Collection uses a geo-referenced information network to manage data on all archived specimens and samples. This network significantly enhances the management and scientific use of materials. A web interface for collection data has been implemented and links specimen records to projects, as a means of tracking collection use. This database will be readily accessible to NPS personnel and other researchers *http://arctos.museum.uaf.edu:8080/uam_db/*.

Data Analysis

The most significant and valuable product of this inventory will be the large collection of well-documented and diverse preparations of scientific specimens. These materials and their associated data will be available for future investigations. As an example, contaminants (especially persistent organic pollutants and radionuclides) are becoming a major concern in Arctic systems. The archival material resulting from these studies may prove crucial to future investigations of temporal and spatial extent of various contaminants in natural populations. The UA Museum has collaborated heavily with various organizations that are assessing contaminants in Alaska and throughout the circumpolar region.

Distribution. Data from these specimens will be combined with existing information to delineate geographic distributions and examine biogeographic patterns of small mammal species. New species and range extensions are expected to be documented in this study. Spatial data incorporated into UAM and NPS databases will be readily accessible for analyses using GIS and other techniques and technologies.

Relative Abundance. Sampling data will be standardized (number of captures per unit time of effort) to compare species abundance (Conroy 1996) and patterns of habitat occupancy in relation to vegetation types (Veireck et al. 1992).

Faunal Composition. The small mammal fauna of each park unit will be described and compared. Checklists of all mammal species will be developed for each park that denote current scientific and vernacular name, biogeographic affinity (nearctic, holarctic, endemic), status (rare and local to common and widespread, insufficiently known, etc.), and documentation level (vouchered with specimens, literature only, sighting reports, etc.).

Parasite Coevolution. Ecto- and endoparasites associated with their mammal host will be used by researchers to examine contemporary and historical ecological relationships, biogeography and phylogeny. Host-parasite systems are ideally suited for cospeciation analysis involving multiple and phylogenetically disparate parasite taxa which occur in each small mammal species under investigation. This process can yield significant information about the history and formation of biotas based on the study of independent lineages of parasites, and in a synergistic manner provide novel insights about the mammal fauna, which are integral to developing an understanding of the history of faunal development and speciation processes (Brooks and McLennan 1991, 1992; Brooks and Hoberg 2000).

Taxonomy and Systematics. Specimens collected for this project will be used in a number of taxonomic and molecular evolutionary investigations (e.g., Cook et al., 2001).

Genetic Analyses. Frozen tissue samples from this inventory will contribute to a variety of genetic studies. Methods include DNA-DNA hybridization (Werman et al. 1990), DNA fingerprinting (Jeffries et al. 1985), restriction-site analysis (Dowling et al 1990), protein electrophoresis (Cook et al. 1992), immunology (Maxson and Maxson 1990) and flow cytometry (Ruedas et al 1993). Investigations using these techniques provide insight into social systems (Burke 1989), effective population sizes (Lande and Barrowclough 1987), the effects of inbreeding and outbreeding depression (O'Brien et al. 1985, and other estimates of genetic structure (Hartl and Clark 1989). Technological and theoretical advances have greatly enhanced our ability to describe genetic variation, delineate species' boundaries, and identify distinct populations and unique lineages (potential units of evolutionary significance—ESUs) (Mayr and Ashlock 1991, Moritz 1994, Mayden and Wood 1995).
Epidemiology. Protozoan preparations (e.g., coccidian) and viral preparations (e.g., hantavirus) from this study will be analyzed using a variety of techniques by a number of laboratories worldwide

Environmental Change. Some of our best data for assessing environmental change has been derived from museum specimens (Banks 1979). Preserved specimens play an important role when investigating environmental change by

providing baseline data for a number of management initiatives, including analyses of biotoxins (George 1987) and stable isotope research.

Partnerships

To successfully complete the stated objectives, the University of Alaska Museum (UAM) and the *Beringian Coevolution Project* (BCP) at Idaho State University (ISU) will work collaboratively with multiple partners including the National Park Service. Inventory efforts to document occurrence, relative abundance, and habitat affinities will generate large series and varieties of permanently preserved materials and associated data sets for taxonomic, zoogeographic, ecological, genetic, parasitological, epidemiological, and other research useful to resource management. Examples of collaborative efforts to analyze these specimens include:

- genetic work currently being conducted at several institutions (e.g. Idaho State University; USGS-BRD Wildlife Genetics Lab-Anchorage),
- associated endoparasitic worms will be studied at the US National Parasite Lab (Beltsville, MD),
- protozoans at the University of New Mexico (Coccidia of the World project), and
- blood-borne pathogens at Harvard School of Public Health (Dr. Sam Telford's lab).

The above collaborators recognize federal ownership of all specimens.

Schedules, Contributions, and Logistics

Field Crews

Field crews, schedules, and sample sites for parks being inventoried in FY03 and FY04 will be arranged with park staff during the spring preceding fieldwork. At this time, more accurate logistics and finalized budgets will be determined. Two crews of four will be established to conduct inventories simultaneously in each park. Potential crew leaders include: Stephen MacDonald (BCP-UAM), Amy Runck (ISU-UAM), and Dr. Joe Cook (ISU-UAM). Stephen MacDonald will conduct field coordination and data for UAM.

On-going or new park projects at Aniakchak National Monument (ANIA) will offer several cost-effective means to piggyback transportation of small mammal crews with other field operations. As a result, sampling in ANIA will not be conducted as a separate effort, but rather in conjunction with park projects, by closely coordinating with the Chief of Natural Resources at KATM.

Inventory Schedule

- FY 2003 (July- August) KEFJ, LACL

- FY 2004 (July-August) ALAG, ANIA, KATM
- Fieldwork details to be developed and finalized by late 2002-early 2003.

Approximate Itinerary

15 July
Two-to-three inventory crews plus gear and equipment arrive.

20 July
Sampling begins.

25 July
Crews move to new sampling area.

30 July
Crews move to new sampling area.

5 Aug-20 Aug
Crews move to final sampling area and finish inventory.

Field Equipment and Supplies for each Field Crew

- 200 Rat snap traps (UAM-BCP)
- 500 Museum Special snap traps (UAM-BCP)
- 200 plastic cup pitfall traps (BCP)
- 2 pitfall installation tools (UAM-BCP)
- 2 5-gallon plastic bucket pitfall traps (BCP)
- 100 Sherman live traps (UAM-BCP)
- 1 dozen assorted snares (UAM-BCP)
- 2 shotguns and ammunition (UAM-BCP)
- 2 full Liquid Nitrogen tanks (UAM-BCP)
- 15 gal. Ethanol (UAM-BCP)
- Assorted field preparation equipment and supplies (UAM-BCP)
- Assorted camping equipment and supplies (UAM-BCP, NPS)
- Per diem/Groceries (BCP, NPS)

NPS Contributions, Coordination, and Logistical Support

- River boat(s) and boatperson(s).
- Fixed-wing aircraft.
- NPS Units will provide radio support for remote camps when possible.
- NPS Field Logistics Coordinator: One for the network during field season to coordinate and schedule flights, bunkhouse space, vehicle use, permits,

training sessions, and other NPS-related details to ensure success of inventory process.

- NPS Volunteers: As needed, when available.
- NPS Data Transfer Coordinator: One NPS data manager person to spearhead and coordinate the transfer of UAM data into specified NPS databases (FY2002-2004).

Products

1. Annual *and* final ***[Catalog of Mammals of Alaska]** reports summarizing field activities and methods, updated species lists, and results (*S. O. MacDonald, UAM*).
   KEFJ, LACL by 15 February 2003
   KATM, ALAG, ANIA by 15 February 2004
   Summarized for SOUTHWEST by 31 December 2003 and 2004, respectively.

2. *Catalog of Recent Mammals of Alaska*. By S. O. MacDonald and J. A. Cook. An updated draft of this document will be available to all park units in the SWAN by the end of the project. Final copies will be provided to NPS upon publication.

3. Reprints of all peer-reviewed journal articles produced from the inventory effort will be provided to NPS upon publication.

4. Specimen Databases (*coordinated for UAM by S.O. MacDonald*)
   UAM will provide datasets to NPS that have been checked using quality control measures specified by NPS. UAM will work closely with NPS to assure data collected in the field is compatible with NPS databases. UAM will assist NPS in the transfer and population of data into NPSecies, NRBib, Dataset Catalog, ANCS+, and GIS Applications. GIS layers will be produced to display transect location and associated species. NPS will assist UAM with the metadata requirements associated with GIS layers.

5. NPS databases will be populated annually to ensure efficient data management. All NPS databases will be fully populated by 31 December 2004.

6. Scientific specimens will be archived and accessible at the following institutions:
   - University of Alaska Museum (mammal skulls, skeletons, skins, whole and partial alcoholics, frozen tissues).
   - Idaho State University (subset of mammal frozen tissues for genetic analyses)

US National Parasite Lab (parasites).

- University of New Mexico (coccidia).
- Harvard School of Public Health (blood and fecal samples).

The above repositories recognize federal ownership of all specimens and associated materials as “works for hire”.

7. Specimen Data (*coordinated for UAM by S.O. MacDonald*)
   Copies of specimen field sheets, data sheets and associated materials (field notebooks, annotated maps, photographs, etc.) will be provided to NPS at the end
   of the analysis period on archival quality storage material.

8. All archived specimen data will be Internet accessible via UAM’s *Geo-Referenced Information Network* that tracks all collection research and use.

9. Field efforts will be coordinated by S. O. MacDonald of UAM.

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Appendix A. Expected and undocumented species list for SWAN park units as generated from NPSpecies.

Park Unit	*Expected undocumented species*
ALAG	*Lemmus trimucronatus, Lepus othus, Microtus oeconomus, Microtus pennsylvanicus, Mustela nivalis, Myotis lucifugus, Sorex cinereus, Sorex hoyi, Sorex monticolus, Sorex tundrensis,* Synaptomys borealis, Zapus hudsonius*
ANIA	*Lepus americanus, Marmota caligata, Sorex tundrensis,*
KATM	*Microtus miurus*, *Sorex tundrensis,** *Sorex hoyi, Sorex monticolus,* *
KEFJ	*Microtus pennsylvanicus, Myotis lucifugus, Sorex palustris,* *
LACL	*Lemmus trimucronatus, Microtus miurus, Myotis lucifugus, Sorex tundrensis*, Sorex monticolus, Sorex palustris,* Synaptomys borealis

Expected and undocumented species for SWAN park units as generated from UAM and ISU lists.

1. ***Park Unit***	1. **Expected undocumented species**
ALAG	*Sorex cinereus, S. monticolus, S. tundrensis, Myotis lucifugus, Mustela erminea, nivalis, Spermophilus parryii, Tamiasciurus hudsonicus, Zapus hudsonius, Clethrionomys rutilus, Dicrostonyx groenlandicus, Lemmus trimucronatus, Microt oeconomus, M. pennsylvanicus, Ondatra zibethicus, Synaptomys borealis, Ereth dorsatum Lemmus trimucronatus, Lepus othus*
ANIA	*Sorex monticolus, Mustela erminea, Spermophilus parryii, Dicrostonyx groenlandicus, Erethizon dorsatum, Lepus othus,*
KATM	*Myotis lucifugus, Mustela erminea, M. nivalis, Lemmus trimucronatus, Lepus americanus*
KEFJ	*Sorex cinereus, S. monticolus, Mustela erminea, Marmota caligata, Tamiasciurus hudsonicus, Clethrionomys rutilus, M. oeconomus, Synaptomys borealis, Erethizon dorsatum, Lepus americanus*
LACL	Sorex monticolus, S. tundrensis, Myotis lucifugus, Mustela erminea, M. nivalis, Marmota caligata, Dicrostonyx groenlandicus, Lemmus trimucronatus, Erethizon dorsatum

Appendix B. Genetic Analysis and Conservation Evaluation

Molecular analysis has been used successfully to address questions related to historical biogeography, phylogeography, molecular ecology, and systematics (e.g., Malhorta et al. 1996: Wayne 1996). Entire journals (e.g., *Conservation Genetics, Molecular Ecology*) are now devoted to these rapidly expanding sub-disciplines within conservation biology. For example, within Southeast Alaska at least two subspecies of northern squirrels are found on the mainland and on 15 islands (Demboski et al. 1998). Of these, the endemic Prince of Wales Island flying squirrel (*Glaucomys sabrinus griseifrons*) is listed as a species of special concern. Using DNA sequence and biogeographical analysis, Demboski et al. (1998) suggests that *G. s. griseifrons* occurs as a distinct population on the southern outer islands within a separate biogeographic subregion (Swarth 1936; MacDonald and Cook 1996). Further work by Bidlack and Cook (2001) has refined and confirmed these conclusions.

The close association of *G. sabrinus* with old growth has been well-documented in Oregon and Washington (Weigl 1978; Witt 1992; Carey 1995, 1996). In these areas, this species has been shown to select nesting sites in large snags (Maser et al. 1978, 1986) and may potentially aid forest regeneration through the dispersal of mycorrhizal fungi (Mowery and Zasada 1984). *G. sabrinus* has also been the subject of studies addressing the impacts of deforestation in Southeast Alaska. Although, the effects of habitat fragmentation on populations *G. sabrinus* are unknown, logging practices have been detrimental to other populations of northern flying squirrels in the Appalachian Mountains (Payne et al. 1989; Weigl et al. 1992; Demboski et al. 1998). Molecular analyses are helping managers determine important biological attributes of this system including connectivity among populations, appropriate management units, and impacts of habitat manipulation.

Appendix C. Museum's specimen catalogue page.

ALASKA FROZEN TISSUE COLLECTION
University of Alaska Museum
NATIONAL PARK SERVICE INVENTORY

Collector:_____

Preparator:_____ Field #:_____

Species:_____ Sex: M F ?

Country/State_____ Quad:_____

National Park:_____

Specific locality:_____

Latitude:_____ Longitude:_____Authority:_____

Date of death:_____preparation:_____

Nature of voucher (Circle one or more): skin skull skeleton

fluid-preserved whole frozen tissues only other_____

Preserved tissue	#tubes	pres	**Preserved tissue**	#tube	pres
Heart			blood		
Kidney			karyotype		
heart & kidney			ectoparasites		
H, K, lung, spleen			nematode		
Liver			cestode		
Spleen			coccidia		
Lung			other( )		
Muscle			other( )		

Condition of tissues (Circle one): (poor) 1 2 3 4 5 (excellent)

Repro condition:_____

Measurements (total-tail-hindfoot-efn-weight):_____

Remarks:_____

_____

_____